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ABSTRACT

The scientific method originated centuries ago, but it is taught only to a limited degree in science classes. It is proposed that the scientific method is not just a method for scientists, but also offers a general approach to problem definition and solving and serves as a guide to problem prevention and solution-challenging. The Scientific Method 14 (SM-14) consists of 14 steps: (1) observing; (2) determining if there is a problem; (3) setting goals and planning; (4) searching, exploring, and gathering evidence; (5) generating creative and logical alternative solutions; (6) evaluating the evidence; (7) forming the hypothesis; (8) challenging the hypothesis; (9) reaching a conclusion; (10) suspending judgment; (11) taking action; (12) using motivation and sensitivity as supporting ingredients; (13) using personal attributes in the process; and (14) applying thinking skills, methods, and processes. Each step is explained in some detail, with anecdotes and illustrations on the facing page. Preparing a self-development program is discussed. (SLD)

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2nd Student Edition (1994)

USA $3.00 PP

SM-14

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD

To be successful in your personal life and in any field of endeavor which you choose, learn SM-14

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Compiled and Written by
Norman W. Edmund
Retired Founder of Edmund Scientific Company

The basic method by which we
Refine, Extend, and Apply Knowledge in all fields through
Problem Origination, Prevention, Solution, and
Challenge of Solution

THE GOLDEN FORMULA
FOR THE GOLDEN AGE OF KNOWLEDGE

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Introductory Message to Students from the Author

Dear Student (Young or Old),

This booklet will be one of the most important pieces of literature to pass your way. Read and treasure it, for it can greatly improve your life.

Be Successful—This Booklet Shows You How!
Success may mean wealth, fame, family, helping others, happiness through being useful, or something else. Whatever your goal may be, you can reach it by studying the "real world smarts" information in this exceptional booklet.

Both Subject and Problem Origination and Solving Knowledge is Needed
In this age of knowledge, learning subject matter is important. However, you will always be faced with problems and decisions, so you must learn and practice the basic method by which we refine, extend, and apply knowledge through problem origination, prevention, solution, and challenge of solutions.

You Must Study This Booklet
I originally intended to write a simple, easy-to-understand booklet. However, when I ran into the controversies mentioned on the opposite page, I realized that I had to offer a complete picture of THE GENERAL PATTERN OF THE SCIENTIFIC METHOD, since most teachers, educators, and others never had it clearly presented and broadly defined. They, too, had to be convinced that it was an excellent problem-originating, -preventing, -solving, and solution-challenging method. So, don't get discouraged if the amount of information in this booklet is overwhelming! Just keep reading and studying it. Get your parents, friends, and teachers to help you.

The Style of This Booklet Makes It Easier for You to Read and Study
Each ingredient is explained on the right-hand pages. Keeping this important information on the right makes review and reinforcement easier.

The top of each left-hand page shows famous examples of how SM-14 ingredients have been used. One of life's biggest problems is choosing a career. The bottom of each left-hand page shows how to apply SM-14 to help you investigate and plan for your career. Study the pages following Ingredient #14, which contain information on achieving real world success.

It's You That Must Make Your Dreams Come True
They won't come true if you read this booklet only once! You must read and reread it. Pay special attention to acquiring and developing the necessary personal attributes and habits. Practice using SM-14. Apply what you learn to real life problems. Make this booklet your handbook for life—a way of life!

Success be with you in your self-development,

Norman W. Edmund

Norman W. Edmund
Retired Founder of Edmund Scientific Company

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THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) CAN HELP YOU

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD requires following a method rather than haphazard action to originate and solve problems and make decisions. It provides you with an excellent guide that helps ensure success in your efforts.

SM-14 consists of fourteen (14) ingredients in easy-to-remember terminology:

Part I

1. Curious Observation
2. Is There a Problem?
3. Goals and Planning
4. Search, Explore, and Gather the Evidence
5. Generate Creative and Logical Alternative Solutions
6. Evaluate the Evidence
7. Make the Educated Guess (Hypothesis)

Part II

8. Challenge the Hypothesis
9. Reach a Conclusion
10. Suspend Judgment

Part III

11. Take Action

Part IV (Supporting Ingredients)

12. Motivation and Sensitivity
13. Personal Attributes
14. Thinking Skills, Methods, and Processes

History of "The Scientific Method"

"The Scientific Method" originated centuries ago. Today it is taught to a very minor and inadequate extent in some science classes. Controversies and misunderstandings arose in the 1950's that retarded its development and inclusion in national science reform programs, therefore, I put quotation marks around it. My research of "The Scientific Method" took over four years and confirmed that it was not just a method for scientists but a general problem-originating, -preventing, -solving, and solution-challenging method—following no set rules or steps but used in a very flexible manner. The name, "The General Pattern of the Scientific Method," is more accurate. With knowledge forecasted to double every 73 days by the year 2020, we must teach and learn methods.

Standardization on SM-14 Ingredients (or similar)

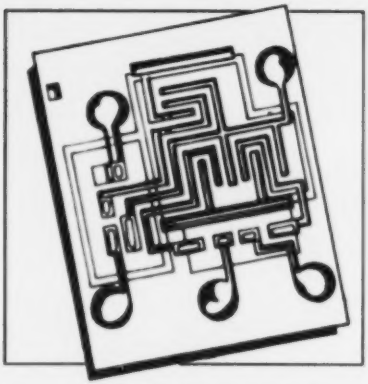
To help put an end to the controversies and misunderstandings, I have prepared a separate report, "Edmund's Idea and Research Report on The General Pattern of the Scientific Method," for the education, science, philosophy, psychology fields (et al), as well as the general public. (For availability, see Page 46.) In this report, I recommend to the educational field that they standardize on teaching SM-14 (or similar) as described in this booklet. Because it is a general method for unusual, ill-structured, or complex problems, it is suitable for supplementing or replacing formulas for:

"The Scientific Method"	Decision Making	Technological Design
General Problem Solving	Operation Research	Medical Diagnostics
Creative Problem Solving	Invention	and many others

THIS BOOKLET IS DEDICATED TO DR. KENNETH B.M. CROOKS (1905-1959), WHOSE ARTICLE, "SUGGESTIONS FOR TEACHING THE SCIENTIFIC METHOD," INSPIRED ME TO WRITE IT. IT IS ALSO DEDICATED TO THOSE MENTIONED ON PAGE 28. YOU WILL FIND A BIBLIOGRAPHIC SKETCH OF DR. CROOKS IN "EDMUND'S IDEA AND RESEARCH REPORT" MENTIONED ABOVE, AS WELL AS IN *BLACK MEDICINE AND SCIENCE* BY V.O. OVELTON.

FAMOUS EXAMPLES OF:

CURIOUS OBSERVATION



In 1969, Ted Hoff revolutionized the micro electronics industry by inventing the micro processor—the computer-on-a-chip. This made it possible to computerize ordinary tools and appliances. Hoff believes that successful inventors are curious and are always asking questions.

Aristotle's influence and importance as a great scientist was possible because he had the attributes needed. He saw an "order" to the world and applied scientific method to his environment by being curious and making astute observations. He made the statement, "All men by nature desire to know."

TO CHOOSE A CAREER:

CURIOUS OBSERVATION

First, it is important to be curious and make observations about yourself in deciding your career.

- Base your inquiry on what you like to do. What jobs have you always found appealing or been curious about? What jobs do you think are challenging? What have you always wanted to do?
- Secondly, a career-conscious person always keeps an eye open for possible career opportunities, literature, fairs, classes, and other leads. This alertness should become second nature.

(Ingredient #1) **(1)**

CURIOUS OBSERVATION

Curious observation is the start of the inductive process. Discovery of new problems, ideas, theories, decisions needed, and problem prevention usually begin with curious observation using the five senses: *smelling—tasting—hearing—feeling—seeing*.
Instruments and tools can be used to help extend these senses.
Use your sense perceptions and projections—visually and mentally. Turn thoughts over and over in your mind. Use reasoning, *your imagination*, and introspection. Being in the right mood, motivated, and sensitive helps! Train your mind to interpret what you see.

Where does problem origination or discovery begin?
The answer is "no one place." Some of the more typical instances are:
1. Things you feel might fill a need—or that irritate or perplex you.
2. Previous experience—You have some thing or theory to investigate.
3. Need project—Looking or brainstorming for problems or fields to investigate.
4. Triggered interest—You decide to investigate as a result of surprise, chance, accidental discovery, observation, illumination, serendipity, reading, experimenting, reflective thinking, or clue. It may also result from a combination of events and things.
5. Assigned, suggested, or thrust—A specific problem or field to pursue.
6. Recognition of potential trouble—Preventive investigation required.
7. Solution of one problem—often reveals other problems.

What should you be seeking and be sensitive to?
1. Any of the above. Stay alert. Develop recognition skills. Be persistent.
2. Problems worthy of solution, practical to investigate new fertile fields.
3. Ordinary things to be examined in a new way and with new meaning.
4.

Curiosities	Relationships	Experiments needed	Leads
Differences	Disturbances	Unexpected failures	Challenges
Similarities	Intimations	Problematic situations	Surprises
Patterns	Unusual results	"Thorns in flesh"	Opportunities
Obstacles	Comparisons	Listen to others	Suppositions

Curious observation also involves other thinking skills, a few of which are:

Evaluating	Visualizing	Imagining	Classifying	Abstracting
Planning	Describing	Questioning	Computing	Communicating
Judging	Interpreting	Conjecturing	Inferring	Measuring

Develop the attribute of curiosity—you use it throughout SM-14.
1. Constantly observe—Ask questions—What, Why, Which, Where, When, Who, How, and If. Visualize what might be. Accept nothing as "fact."
2. Be an innovator—Cultivate curiosity to find ideas. See Pages 13 & 35.
3. Read, skip, and skim publications for data, ideas, and triggers for ideas.

Having found something, continue on now and define the problem. If necessary, gather more information before trying to define the problem. Any solutions you derive, no matter how good, should be considered tentative.

FAMOUS EXAMPLES OF:

IS THERE A PROBLEM?

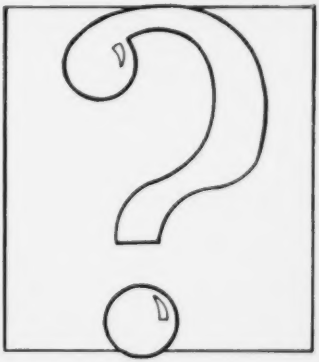
Thomas J. Watson recognized a "felt difficulty" and developed IBM into a leader in the field of computer technology. This is an example of how the innovative and creative efforts of one man, his organization, and related industries have added trillions of dollars to our gross national product.

What? Why? Which? Where? When? Who? How? If? Thomas Edison was constantly on the alert to find and solve problems. He held more than 1,000 patents, including famous ones for the electric light, phonograph, movie projector, and microphone— adding trillions of dollars to our gross national product.

TO CHOOSE A CAREER:

IS THERE A PROBLEM?

At this stage, try to pinpoint the problem. Is your problem "What career shall I choose?" . . . or . . . "What career information should I study to prepare for the time when I'm ready to make a decision?" What are my natural and strongest abilities? (See Page 32.) When defining your problem, there are other considerations besides finding a way to earn money. There are your goals in life and what you can contribute to make this world a better place in which to live.



(Ingredient #2)

IS THERE A PROBLEM? (2)

It is customary to word the problem in the form of a question rather than as a declarative statement. The major question may be followed by statements or questions of a minor nature. A problem is often referred to as a "felt or perceived difficulty."

Look at problems as challenges and opportunities. Develop a passion to solve! Define the problem carefully so you know what direction to take.

1. It prevents you from wasting time and may indicate whether it is solvable.
2. A wide enough (but not too wide) definition allows for alternate solutions.
3. "A problem properly defined is often half-solved."

Things to help you define and understand the problem properly

1. Consider purpose, goals, criteria, and significance.
2. Ask What—Why—Which—Where—When—Who—How—If.
3. Know the domains in which the problem falls.
4. If you don't know enough about the subject, you may have to loop ahead to Ingredient #4 and search for information to help define the problem.
5. If problem was assigned to you, review its origin. Read and reread it.
6. Define the problem's deep (or basic) structure. Juggle the elements.
7. End with a question that is brief, clear, purposeful, and thought-provoking.
8. Plan to revise the definition as your research proceeds. Read and reread it.
9. Things to write down, consider, or do about the problem:

Characteristics	Unknowns	Make concept map
Attributes	Symbols	Draw pictures
Critical issues	Concepts involved	Use models
Analogies	Separate elements	Quantitative aspects
Use imagery	Make idea tree	Other representations
Challenge unfounded assumptions		State problem another way

Tentative solutions—Keep an Open Mind

Be alert for any possible solutions. Even if enthused with any solutions that arise, consider them tentative until you use Ingredients #4 through #6.

The Power of Mathematics

A knowledge of arithmetic and higher mathematics is essential in solving problems in physics, chemistry, and many other disciplines—as well as many real world problems. School, college, and employment tests all include questions and problems to determine your mathematical skills.

YOU MUST LEARN AS MUCH MATH AS YOU MAY NEED!

MOST IMPORTANT MESSAGE IN THIS BOOKLET

Studying and learning is not enough. For problem solving, success in life, and happiness, you must strengthen your good personal attributes, acquire desirable ones, and control your negative ones. Getting the right combination is up to you. Parents, schools, religious organizations, and others offer some help but it is mainly up to you (see page 29).

FAMOUS EXAMPLES OF:

GOALS AND PLANNING

Anthropologist and author Margaret Mead had a lifetime goal to learn about human nature. Her research answered basic questions about human personality. Her plan of action included college study, specialized training, and actually living with primitive societies to observe and study them.

It was due to careful planning that Gregor Mendel was successful in his experiments with pea plants which provided new insight into the laws of heredity. His goal was to find out how characteristics of parents are passed on to offspring.

TO CHOOSE A CAREER:

GOALS AND PLANNING

Your goal is to choose a career by making a study of various careers and analyzing yourself to see which ones suit your talents and emotional requirements. Use the top of the opposite page as a guide. Start now! Plan early for your career.

Complete a list of desirable careers. This will reduce the scope of your search. Review basic principles for planning on opposite page.

Investigate the type of education and training required. Prepare a plan of action and things to do for each ingredient.

(Ingredient #3)

GOALS AND PLANNING

(3)

GOALS—End results you want to achieve in solving a problem

1. Goals must be realistic, flexible, and subject to change.
2. Put goals in writing. This helps analyze priorities and avoid carelessness.
3. Consider methods, processes, technologies, systems, strategies, and formulas needed.
4. Set target dates for stages and completion.
5. Learn to process information efficiently.

In considering goals, think about:

1. Real purpose involved
2. Where goal is leading
3. Long & short term goals
4. Future consequences
5. Sub-goals
6. Criteria to use
7. Values to use
8. Time/budget
9. Perfection not always needed
10. Revising as required
11. Your basic needs
12. Measurability/specific end

PLANNING—How to reach your goals—Always Think and Plan Ahead

1. Planning speeds solution—Avoids wasted time & effort. Put plans in writing.
2. Develop plan to use today's huge computer databases of information.
3. Abstract & outline: theories, concepts & basic principles involved in the problem.
4. Consider breaking down into sub-problems—each may require a plan.
5. Plan must be flexible. When working on complex, ill-structured problems, things will change frequently. Thus, don't start with too detailed a plan.
6. Plan for overall solution—Preliminary program for each ingredient of SM-14.
7. At start of work on each ingredient, prepare revised program for this ingredient.
8. Compile tentative solutions. Know the scope of areas you are going to search.
9. Experiment and test. Watch for methods to test tentative solutions.
10. Similar problems solved before—Review records to benefit from experiences.
11. Intuition and insight—use to save you time and aid direction.
12. Build your team—involve them in goals and planning.
13. When solving ill-structured problems you must tolerate ambiguities.
14. Plan how to control constants and variables.

A few other things to consider in your planning:

Keep log book	Start with easiest sub-problems
Time, budget, priorities	Utilize sketches and diagrams
Methods, strategies	List factors contributing to solution
Resources available	Criteria to meet or establish
Algorithms	Supplies—facilities—instruments
Models, analogies	Build up your library and files
Impact on society	Approvals and decisions of others
Emotions, stress	Trial and error
Alternate plans	Laws, licenses, legalities, patent search
Watch for clues	Apply innovations and creativity
Anticipate troubles	Assignment of responsibilities
Thinking aloud	"Anything goes" theory
Checking feedback	Challenge assumptions

FORECASTING: Problem prevention and solving often requires planning ahead and forecasting the future. Intuition may help, but research is often needed. Studying-using models, forecasting, and making decisions under uncertainty helps.

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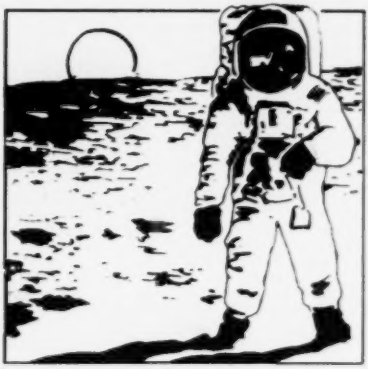
FAMOUS EXAMPLES OF:

SEARCH, EXPLORE, AND GATHER THE EVIDENCE



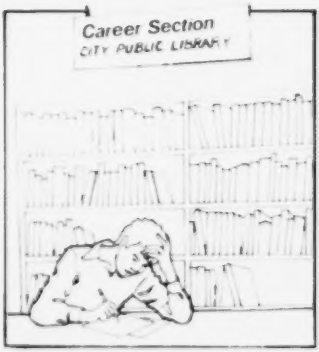
Because of thorough searching, exploration, and information gathering, the teams of NASA scientists, engineers, technicians, and astronauts were able to solve the complex problem of landing man on the moon. The dream became a reality on July 20, 1969, when Neil Armstrong took man's first step on the moon.

In searching for information to include in this booklet, I used over 15,000 Post-it™ Notes to mark helpful pages. Dr. Art Fry invented 3M's Post-it™ Notes to satisfy a felt need to efficiently mark pages. Experimenting with a special adhesive developed by 3M's Dr. Silver, Dr. Fry explored and persevered to develop his idea into a fabulously successful product.

TO CHOOSE A CAREER:

SEARCH, EXPLORE, AND GATHER THE EVIDENCE

Develop a passion for learning about various careers. Read Pages 11 & 13. You will be using these ingredients concurrently. Refer to Pages 30 & 33 for more information on careers, and how to search, explore, and gather the evidence. Build up a list of tentative careers. Use a notebook page for each one to make notes. Back it up with a folder on each career or category. Keep records of which books or periodicals have the best information about specific careers.



(Ingredient #4) **(4)**

SEARCH, EXPLORE, AND GATHER THE EVIDENCE

This is the heart of problem solving. You start to search everywhere, explore all angles, leads, clues, and sources of information. Pick out the basic principles of the material you read, see, or hear. Gather all the evidence that will help you solve the problem, always trying to use innovation and creativity, thus building your list of possible tentative solutions.
Learn how to process information productively. Put your thoughts in writing.

Search your mind for tentative solutions

Before loading your mind with data, other people's opinions, and so-called "facts," list all possible tentative solutions you can think of for your main problem and any sub-problems. Reasons: (1) Provides you with direction and scope in your search. (2) Enables you to utilize imagination before being influenced by prevailing thoughts and theories.

Review plans and prepare your program

1. Keep log
2. Build files—use all resources
3. Enlist team of advisors
4. Prepare broad literature search
5. List any known sub-problems
6. Read about How-To-Research

SEE PAGE 33 FOR AIDS AND SUGGESTIONS ON WHERE AND HOW TO SEARCH

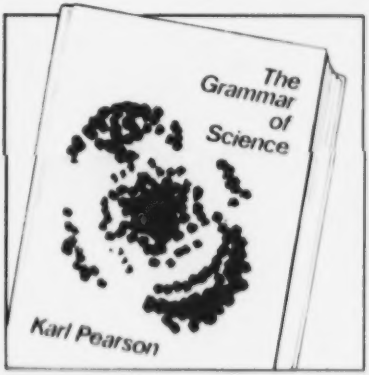
Possible methods, processes, strategies, technologies, and systems

- Redefine problem as needed
- Draw inferences
- Watch for patterns
- Classify
- Make associations
- Discard the irrelevant
- Find inter-relationships
- Simulate or improvise
- Anticipate the unexpected
- Sampling and statistics
- Measurements
- Work backwards
- Algorithms
- List attributes of subject
- Utilize routines
- Group brainstorm
- Imitate nature
- Utilize computers
- Spot key factors
- Solve sub-problems first
- State problem another way
- Compare to other problems
- Abstract basic principles
- Be flexible—vary your attack
- Watch for leads, clues, hints
- Control variables—causes and effects
- Watch for surprise discoveries
- Plan experiments—be curious
- Interpret data—use all data
- Trial and error
- Look for similarities and differences
- Visualize—watch for "oddities"
- Logical reasoning and speculation
- Use checklists, models and analogies
- Use qualitative and quantitative analysis
- Use sketches, trees, concept maps
- Use flow charts, spreadsheets, symbols
- Look at problem from different angle

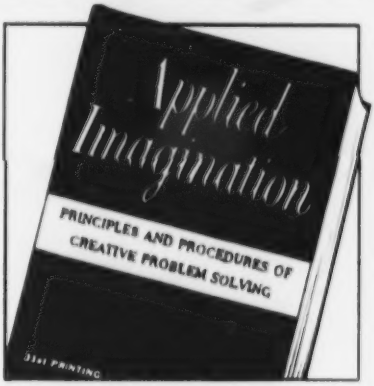
DEVELOP YOUR REFLECTIVE-DIRECTED, SPECULATIVE THINKING

Talk to yourself in both language and images . . . silently or aloud. Daydream with your thoughts directed to thinking about the data you reviewed. Think reflectively while searching and while doing routine things such as exercising. Jump back and forth among logical, critical, imaginative, and wild thinking. The interpretation of the data you review is of prime importance! Watch for illumination or gradual insight. Remember, "anything goes" (that is ethical). It is often out-of-the-ordinary thinking, methods, and surprises that produce discoveries and solutions. Try "kicking the problem around."

FAMOUS EXAMPLES OF: **GENERATE CREATIVE AND LOGICAL ALTERNATIVE SOLUTIONS**



Karl Pearson, in his famous book, The Grammar of Science, published in 1892, stressed creativity as a separate feature of "the scientific method." His exact words were "the discovery of scientific laws by aid of the creative imagination." He also advocated the scientific habit of mind for solving all problems of life.

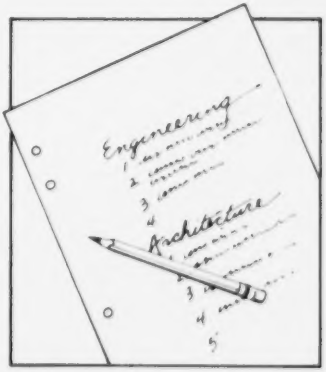


Alex F. Osborne authored Applied Imagination and founded the Creative Education Foundation. Along with Dr. J.P. Guilford, he made a tremendous contribution to the popularization of interest in and development of the techniques of creative thinking—urging generating alternatives. These efforts spawned many books and seminars.

TO CHOOSE A CAREER: **GENERATE CREATIVE AND LOGICAL ALTERNATIVE SOLUTIONS**

While gathering information, build your list of tentative career choices. Make only minor evaluations at this stage so that the size of your list is practical. Do not fully evaluate or judge your choices yet.

There is not just one job that is right for you. There are numerous careers in which a person can be successful and happy. Consider creating your own career. There are many successful people who made their own job by filling a need not currently being met.



GENERATE CREATIVE & LOGICAL ALTERNATIVE SOLUTIONS

Logical solutions *(or Trial and Error)*

You can solve many problems the same way many great discoveries have been made—by trial and error or by using gradual, systematic, steady, analytical, judicial reasoning and logic. You gather the data and fit it together. What *was* a puzzle falls into a logical order. Aha! You have a discovery or solution to your problem. Most importantly, however, problems are solved by the leap of the imagination, as often the solutions are infinite.

Innovative solutions

Search out other people's ideas. Use as they are or adapt for your particular problem by combining reflective thinking and your creative abilities.

Creative solutions—Use of imagination

Creativity is usually described as taking two existing ideas and combining them into a new and better idea. It is also termed divergent thinking, lateral thinking, insight, intuition, flash of inspiration, innovation, ideation, guided design, generative thinking, productive thinking, etc. Successful people have also found imaginative thinking helpful in deciding what ideas or directions not to use or consider in detail. *There is not enough space to discuss all the ways to generate alternative solutions. Below are what I consider to be the most important methods (see pages 34-37, also).*

Reflective thinking—You search; explore; follow leads; gather pertinent data, information, basic principles, concepts, and use reflective thinking. See Page 11. You can also use rest-illumination or rest-insight. You load your mind with subject data—rest— then start thinking about your problem again in a relaxed manner.

Triggers—Things that stimulate your mind's store of stocked memories and cause recall and new train of thought. It's best to load your mind with data pertinent to your current problem. It is the prepared or loaded mind that can best be triggered. At that point, you then:

Experiment or visualize	Brainstorm
Have discussions—pick minds	Browse through a store
Attend conferences and exhibits	Search your files
Use a computer idea program	Trial and error procedures

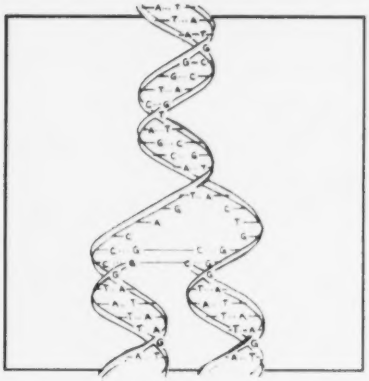
While you are doing all these things, you are reflecting on your problem as you acquire more information. Then, EUREKA—suddenly ILLUMINATION comes—or more gradual insight climaxes! Something has triggered your mind and you have an idea, lead, discovery, or a tentative solution. This may be a small or very big idea.

Most Productive of All: Read, skip, and skim through a wide variety of magazines, newspapers, and books. These are the nation's idea banks which are filled with things to trigger your mind. Visit your library where there are hundreds of magazines on display. Books on creativity and school courses usually fail to stress the value and importance of this.

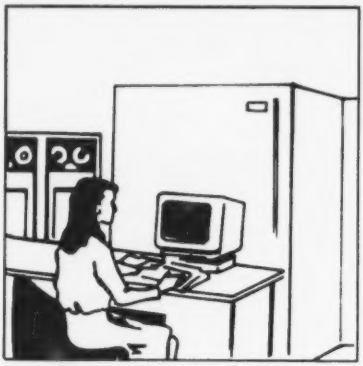
PARENTS AND STUDENTS—Work together in learning and reviewing this book. Try the SM-14 method on real world problems. Parents must have a continuous learning program. Never having been taught SM-14, they should learn it now!

FAMOUS EXAMPLES OF:

EVALUATE THE EVIDENCE



After evaluating all the evidence, biologist James Watson and biophysicist Francis Crick solved one of nature's greatest puzzles— the structure of the DNA molecule . . . the genetic "blueprint" that dictates the traits which living things inherit. They earned a Nobel prize for this discovery in 1962.



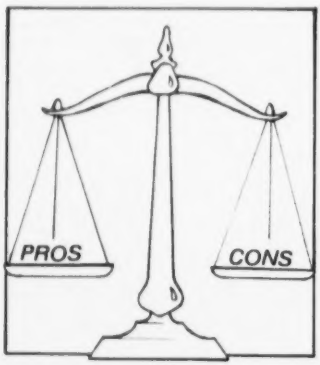
Herbert A. Simon, Nobel Laureate, and his associates researched the human problem-solving process. Through evaluation of the evidence, they arrived at the hypothesis that a great variety of problems could be solved by use of a computer. Dr. Simon's books contain a wealth of evidence on problem solving and artificial intelligence.

TO CHOOSE A CAREER:

EVALUATE THE EVIDENCE

Now work on a better evaluation and weigh the evidence for each career on your tentative list. Take a systematic approach. Prepare a spreadsheet. If a computer is available—use it. Establish criteria such as: money, personal appeal, physical suitability, education required vs. cost, etc.

Rate each career on your list by a scale or grade you devise. You might have to do more research to properly grade them. Experiment by spending a day on a job in the chosen fields or working in community service.



(Ingredient #6)

EVALUATE THE EVIDENCE

(6)

By now you should have a list of tentative solutions that are candidates for your educated guess or hypothesis. It is also the stage for experimenting and testing. The final choice is often called your working hypothesis and will be your Ingredient #7.

Starting guides to consider before working on each ingredient

1. *Problem*—Should it be redefined or reframed?
2. *Goals and planning*—Any changes? Any new leads or clues? Planning ahead?
3. *Goal-referencing approach*—Where you started, are at now, and still need to go.
4. *Looking back*—Have you been using the right attributes, methods, strategies, technologies, plus curious observation? Have you consulted your advisor? Have you had a team meeting? Are you keeping your log up-to-date? Being on the right path is important!
5. *Are you using innovation, creativity, watching for surprises?* Are you alert to clues and leads?
6. *Are you putting thoughts and ideas into writing?* Using all available resources?

Evaluating your tentative hypotheses

1. If data on any of these hypotheses is insufficient, gather additional information.
2. Check against any list of criteria, formulas, and routines you have established.
3. It may be helpful to read the information on Ingredient #7 to familiarize yourself with the characteristics and traits your working hypothesis must have. Also, read Ingredient #8 to alert you as to how it will have to be challenged.

Tests, Experiments and Other Methods, Strategies, and Techniques of Evaluating

Logical reasoning	Measuring	Mathematical solution
Consult literature	Surveys	Independent lab test
Collaborators	Interviews	Expert opinions
Controlled experiments	Modeling	Concepts correct?
Dis-confirming test	Graphs	Improvisation
Data base reliable?	Sampling	Disqualifying
Consider consequences	Speculation	Make predictions
Statistical analysis	Simulations	Challenge assumptions
Design special instruments	"Live It"	Computer testing
"Anything goes" theory	Visualizing	Need to ripen more?

Chart your solutions to weigh the evidence more carefully and make your choice. Criteria can be graded by as many facets, characteristics or angles as you desire. You can have individual charts or a joint one. Tailor headings to fit your problem.

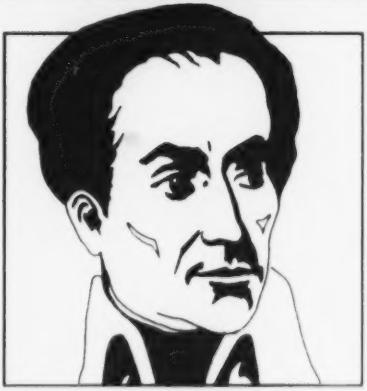
Possible Comparison Chart								
Tentative	Test Results		Suitability		Feasibility		Acceptability	
Choices	#1	#2	#1	#2	#1	#2	#1	#2
Solution A	Against	For	30%	Okay	60%	Okay	50%	90%
Solution B	For	Against	50%	No	80%	No	90%	20%

Learn To Write Neatly and Small—Keep Orderly Files

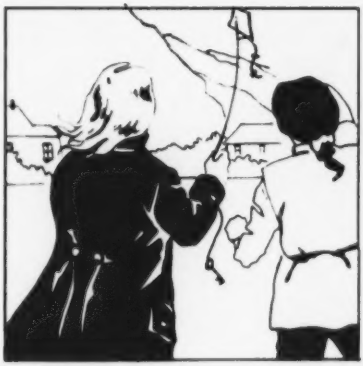
Throughout your life you will have to put your thoughts on paper. Learn (and make it a habit) to write neatly and small. Also, organize your information into orderly files. Use inexpensive, plastic crate, file folder holders

FAMOUS EXAMPLES OF:

MAKE THE EDUCATED GUESS (HYPOTHESIS)



Simón Bolivar—Five republics of South America term him father of their independence. He faced the problem of how to free his country (Venezuela) from colonial oppression. When one hypothesis failed, he generated another and another until he finally succeeded. Leadership requires problem origination, solving, challenge, and action.



Benjamin Franklin is well known for his famous kite experiment in which he explored the nature of lightning. He gathered evidence, formed a hypothesis, and in 1749 after performing his dangerous kite experiment, Franklin concluded that lightning is an electric charge.

TO CHOOSE A CAREER:

MAKE THE EDUCATED GUESS (HYPOTHESIS)

After reviewing your spreadsheet, make an educated guess. Usually you have only one hypothesis; but, in a case of career choice, you may want to research several careers. Then, over a period of years, you must constantly review and compare.

Write your hypothesis in statement form. Explain the reasoning that supports your choice. For each career, prepare predictions about: earnings, education time, job enjoyment, service to society, etc.

16 "The law that only problem-solvers survive is as inflexibly relentless as the law of gravity"

(Ingredient #7) (7)

MAKE THE EDUCATED GUESS (HYPOTHESIS)

Review the starting guides at top of Ingredient #6 on Page 15. Your educated guess—technically, the hypothesis—is a proposed solution to the most recent definition of your problem. It is your choice of the most-likely-to-be-successful solution from the list of contending ones which you evaluated.

Terminology, definitions, and descriptions:

The hypothesis is often called "the educated guess," because scientists have long recognized the difficulty of arriving at the real "truth."

Working hypothesis is a term used to describe this proposed solution. It is only a "candidate for truth," as it must be challenged under Ingredient #8.

A hypothesis would be a theory of nature in scientific fields. In other fields, it could be a decision, plan, diagnosed illness, idea, design, invention, etc.

More than one hypothesis (hypotheses)—you might propose more than one solution. Problems in the social sciences often require several hypotheses.

A perfect solution is seldom obtained in solving complex problems.

Inductive reasoning has helped reach your hypothesis. See Ingredient #14.

Valuable even if proven false—a hypothesis will often be wrong but may lead to a discovery, a new field to explore, or a modification of the hypothesis.

The characteristics or traits of a hypothesis

These are desirable but not always essential or possible

Relevant and adequate	Adds to existing knowledge
Verifiable or falsifiable	Consistent with existing knowledge
Logically possible	In simplest terms possible
Conducive to further inquiry	Answers defined problem

Predict consequences

Now that you have chosen a hypothesis, you must make predictions of why and how something will occur, based on the accuracy of your hypothesis. Testing these predictions helps you challenge, verify, justify, or falsify your hypothesis in Ingredient #8. Then others can do so—after you take action at Ingredient #11.

Types of consequences an ! predictions:

If change is made, consequences will be . . .
If experiment is made, it will show . . .
If reasoned out, results will be . . .
If cost and benefits are computed, they will show . . .
If survey or interview is conducted, it will show . . .
If mathematical computation is made using certain data, it will show . . .
If a model is made, this will happen . . .
If a computer simulation is programmed, it will show . . .
If a scenario is prepared, enumerating all possible results, it will be . . .

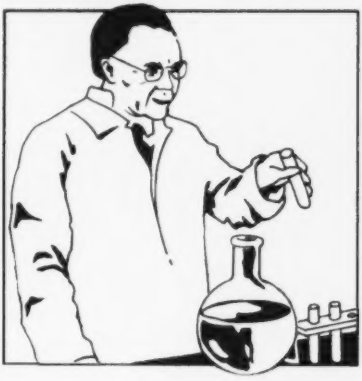
Conceptual Thinking

Since your birth, you've been classifying and forming concepts (such as what a mother is, what food is, etc.) Thus, in thinking reflectively, you are directing your thoughts to seek a conceptual theory that will be your "educated guess."

FAMOUS EXAMPLES OF:

CHALLENGE THE HYPOTHESIS

While working as a patent attorney, Chester F. Carlson decided to design a fast, easy, and inexpensive way to make copies of text and line drawings. After challenging several hypotheses, he successfully produced the first xerographic copy in 1937 and was issued his first patent in 1940. This invention added billions of dollars to gross national product.



Dr. Percey L. Julian, by synthesis of the drug physostigmine, brought the healing drug cortisone within the reach of millions. He defeated the challenge of a British rival and proved his theory. Dr. Julian's appointment to head The Glidden Company's research marked the turning point in acceptance of black scientists in the United States.

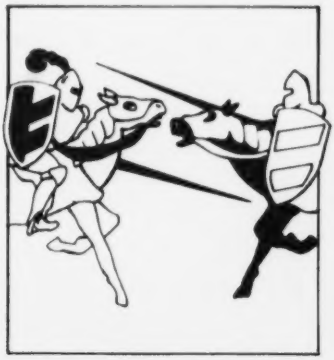
TO CHOOSE A CAREER:

CHALLENGE THE HYPOTHESIS

Challenge your hypothesis by trying out your career choice. Suggestions:

- Be a volunteer
- Job shadow
- Summer class
- Summer job
- Join a special interest club
- Get involved in extra-curricular activities related to career
- Community services
- Check on long-term prospects
- Verify your predictions made in Ingredient #7

While experimenting with your career choice, make observations and ask questions. Continue to search for evidence.



PART II—Challenge to Suspend Judgment
The Context of Verification—The Deductive Process

(8)

(Ingredient #8)

CHALLENGE THE HYPOTHESIS

Usually the stage for final experimentation and testing.
Review the starting guides listed at the top of Ingredient #6 on Page 15.
The degree of challenge to your hypothesis will depend on the type of problem and its importance. It can range from just seeking "a good enough" solution (but not a haphazard or lazy one) to the much more rigorous challenge to which scientific theory must be subjected.
To accommodate a broad range, Dr. Crooks used the term "Challenge." Most of the old formulas for "The Scientific Method" use the terms verification, justification, refutability, validity, rectification, falsification, testing the theories, test prediction, experimentation to test, look back, and many similar terms indicating that the hypothesis should be challenged.

Experimenting, testing, and challenging the hypothesis
Falsification: Sir Karl Popper advocates trying to prove a hypothesis to be false rather than trying to prove it right. This may save time and avoid bias.
Verification: Many disagree with his falsification theory and believe various methods should be used to verify the hypothesis.
Who Is Right?: This is an extremely controversial and difficult question to answer. Try both approaches mentioned above. Gather evidence for and against your hypothesis.
Predictions: Use to challenge your hypothesis. Under Ingredient #7, you made certain predictions that resulted from your hypothesis. The way to challenge your hypothesis is to try to prove these false, probably true, or supported.
Modify Your Hypothesis: In testing your predictions, if you find something wrong, backtrack to Ingredient #7, modify your hypothesis, and change your predictions. If it fails completely, backtrack to Ingredient #4 or #5. We learn from failures.
Control Variables: Vary one thing at a time—make notes on each.

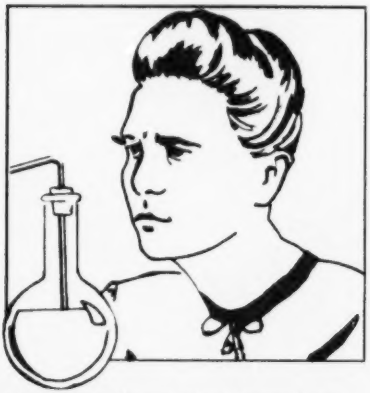
Repeatability of your tests and experiments
For your hypothesis to be accepted by others, your testing results must be able to be repeated by you and those who will want to verify your theory.

Log all tests	Results must fit known "facts"	Be accurate
Report unknowns	Experiments must be complete enough	Review data
Control stress	Results must be consistent	Be honest
Try for simplicity	Watch for "bugs" that spoil tests	Get advice
Use sampling	Use statistical verification	Use math

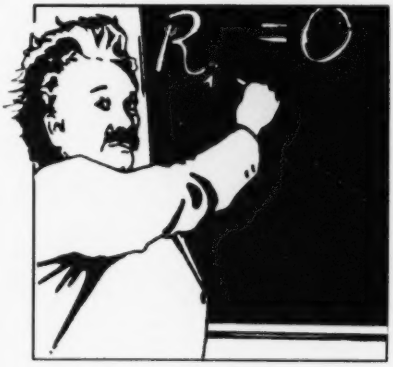
Other suggestions
Fault Tree—Prepare one on how your hypothesis or tests can possibly fail.
Alternate Hypothesis—Be curious, observant, alert for a better hypothesis.
Dis-Confirming Evidence—Don't ignore, follow up. Be critical.
Competing Hypotheses—Verify by eliminating these, but remain flexible.
Some Hypotheses Not Verifiable—Your hypothesis may not be verifiable if it's in social science, geological fields, or some others.
Consequences and Contingencies—What results from your hypothesis?

FAMOUS EXAMPLES OF:

REACH A CONCLUSION



Curious to know what ingredient made uranium ore so powerfully radioactive, Marie Curie gathered the evidence. In her search and exploration, she tested all known chemical bodies, discovering two new elements: radium and polonium. For these discoveries, she was awarded the Nobel Prize in Chemistry in 1911.



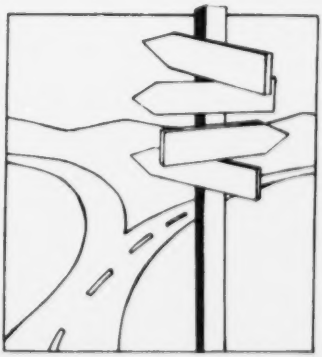
Albert Einstein's conclusion about the theory of relativity has been tested over and over and has never been disproven. Two famous quotes of his: "Imagination is more important than knowledge, for knowledge is limited." "The formulation of a problem is far more often essential than its solution, which may be merely a matter of mathematical or experimental skill."

TO CHOOSE A CAREER:

REACH A CONCLUSION

Okay, you made a choice and you challenged it. Does it still appeal to you? How do you like this career field? Does it appear to be the best possible choice? Why or why not? Summarize what you have learned.

If you do have second thoughts or doubts about your choice, remember that in using SM-14 there is a lot of backtracking, jumping, and skipping. Perhaps you should go back to the exploration stage and begin again.



(Ingredient #9)
REACH A CONCLUSION

Begin by reviewing the starting guides listed at the top of Page 15.
You have challenged your working hypothesis. Now comes the conclusion.
If your hypothesis is partially wrong, you backtrack, modify, and then challenge again.
If completely wrong, you backtrack and take another path. We learn from our failures. Do not become discouraged! Even great men and women are frequently wrong. If your hypothesis passes the important tests,
YOU HAVE REACHED YOUR CONCLUSION!

Your conclusion should be (among other things):

1. broad enough to fit all acceptable data;
2. limited enough to meet special exceptions;
3. consistent when tested by you (and others) again and again;
4. seldom extended beyond the evidence;
5. suitable to base a report on, if one is scheduled; and
6. an answer to the problem, as you have finally defined it.

Now an especially good "look back" to re-evaluate your investigation

Gathered enough information?	Ethical considerations?
Experiments properly performed?	Overall accuracy good?
No fraud by teammates?	No bias has crept in?
Variables properly controlled?	No wrong assumptions?
Any other possible goofs or errors?	Anything overlooked?
All consequences considered?	Feedback?
Any conceptual blocks?	Environment considered?

Things to do now in preparation for Ingredient #11—TAKE ACTION
While everything is fresh in your memory, think about and prepare notes on:
Limitations. If there were any limitations on your efforts or results in defining the problem, the search for evidence, or the challenge phase, include them in preparation for reporting under Ingredient #11.
Speculations and Looking Forward. If you were doing a project that advances the knowledge in your field, you might want to prepare some speculations or predictions even beyond what the evidence supports. Label as speculations.
Research Method Recommendations. Based on your experience, make recommendations, give warnings, hints, and references to those who may try to challenge, verify, or falsify your conclusions.
Conclusion Recommendations and Presentation. If you work on a decision problem, plan, management problem, etc., you may want to prepare recommendations based on your conclusions to submit to authorities.

Intelligent Compromise: In problem-solving or decision-making in the "inexact" social sciences, etc., your conclusions may have to be an intelligent compromise. The solution of any problem (and its acceptance) depends on good human relations. Consult those who will be affected by your conclusions.

Measuring: Another essence of problem solving. Learn such things as:

Metric system	Weighing	Charting and graphing
Temperature scales	Probability theory	Statistical methods
Instrument use	Cost containment	Computer programs

BEST COPY AVAILABLE

FAMOUS EXAMPLES OF:

SUSPEND JUDGMENT

In December 1967, Christiaan Barnard performed the world's first human heart transplant in Cape Town, South Africa. Before reaching a conclusion that the operation was successful, Dr. Barnard suspended judgment in order to observe and gather more information from the patient.

Suspend judgment if you think the Japanese are only imitators. Japan made great strides by just being innovative. Learning to be a good innovator is the first step on the road to creativity. Today, Japan is quickly becoming more creative. To remain competitive, *You Must Become a Better Innovator and More Creative!*

TO CHOOSE A CAREER:

SUSPEND JUDGMENT

Keep an open mind and be willing to accept new information regarding your career choice.

For example, if new career forecasts predict an oversupply of employees in your field, or while you were doing volunteer work you discovered aspects you didn't like, you should reconsider. Go back to Ingredient #4 to renew your search.

Consider cross-training; be able to pursue several different careers.

Adaptability will be essential in the fast-changing times ahead.

22 "Recognize that doing well now isn't good enough—what will the future require?"

(Ingredient #10)

SUSPEND JUDGMENT (10)

Throughout a project, a good researcher has an open mind and a skeptical, but practical, attitude, always suspending judgment to some degree.

You have spent a lot of time and effort to reach a final conclusion, but now you must change your attitude and suspend judgment. Do not "fall in love" with your final hypothesis. Watch for other concepts or trains of thought.

An excellent description of this ingredient was given by Dr. Crooks in his 1958 paper (mentioned on page 24). Discussing the ingredient of "Suspended Judgment," he stated:

> The investigator must stick to his conclusion until it is proved wrong, but he must keep an open mind and be ready to accept new evidence or speculations if sufficiently convincing. He is therefore ready to adjust his own views if they are untenable.
>
> **This is the crux of the scientific attitude: an abiding faith in some view or opinion allied to a healthy skepticism; a questioning challenging doubt of new ideas; but a mind definitely open to new ideas.**
>
> This sounds conflicting, but it is not. The true scientist or the citizen with a scientific attitude is no bigoted stand-patter, but he is no wishy-washy turn-coat either; he does not go chasing after strange idols just because they are new, nor does he condemn another idea just because it is old.
>
> **He realizes that truth is not simple, that knowledge is forever growing, and that opinions thought correct today in the light of present knowledge may be thought incorrect tomorrow because of new discoveries or the projection of new ideas.**

IMPORTANT! There can be great flexibility in the order in which SM-14 ingredients are utilized. Ingredients are numbered and in their usual order of use. Utilizing the ingredients in solving a problem, you may often:

1. Skip ahead
2. Backtrack
3. Stall
4. Loop ahead or back
5. Combine two or more ingredients
6. Use various combinations

Never refer to the ingredients as steps or rules! However, in many of the methods used under the ingredients, there may be steps or rules to follow.

Develop Your Communication Skills

Educators and employers increasingly stress the importance of verbal and written communication skills. There is a movement to teach writing across the curricula. Develop proficiency in the following:

Vocabulary	Spelling and punctuation	Public speaking
English grammar	Subject terminology	How to write a report
English composition	Communication knowledge	Self-confidence

Analyze Yourself—Most of us think in mental images rather than words! Are you a "visualizer" or a "mathematizer"?

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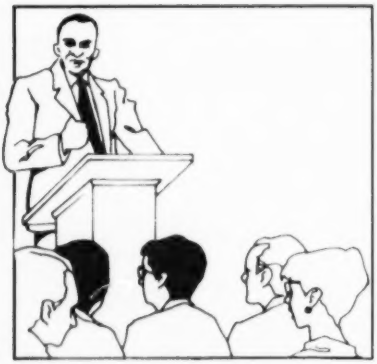
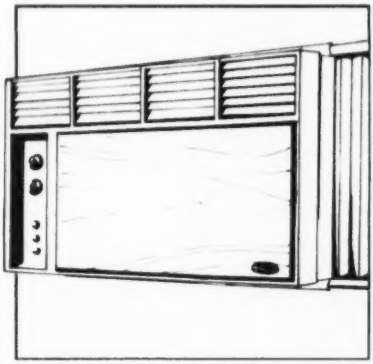
FAMOUS EXAMPLES OF:

TAKE ACTION



Dr. Kenneth B.M. Crooks *took action* by presenting his paper on "Suggestions for Teaching the Scientific Method" at a meeting of the National Association of Biology Teachers (AAAS Convention in December 1958). His paper was published in the ABT in 1961.

Your author read the paper and eventually wrote this booklet.



The action of Willis Carrier as he persevered to market his invention of the air conditioner has contributed trillions of dollars to gross world product.

The Value of New Technologies
Writing and producing this booklet would have taken an additional two years but for the development of:

- Air-conditioning
- Copy Machine
- Post-it™ Notes
- Computer
- New Library Sciences

TO CHOOSE A CAREER:

TAKE ACTION

Anticipate action—plan ahead! The action you take depends on your grade level or stage of life. If you will soon graduate from high school, you must apply at selected colleges. If you expect to enter the workforce, you must investigate which companies offer the best opportunities. Whether you are college-bound, changing careers, or entering the workforce, remember that *some* action should be taken.

PART III—Take Action
Submission for Peer Review, Effort to Gain Acceptance, or Implementation

(Ingredient #11) **(11)**

TAKE ACTION

Prepare for action! This is often called the "gaining acceptance stage."

1. Review your plans and goals. Have the courage to act now.
2. Innovation and creativity can help immensely. Read how to present, sell, and gain acceptance of your concluding hypothesis. Get other opinions.
3. Give proper credit to your team, reference sources, and associates.
4. Report the social and ecological effects of your hypothesis.
5. Look ahead—mention possibilities that others may not see.

The action you take depends on the nature of your investigation.

Scientific theory, process, discovery

You will usually prepare a report using the IMRAD format of Introduction, Method, Results, and Discussion. This can be submitted to a scientific journal for peer review and possible publication. Other possibilities:

Publish book	Report to superiors	Report to project sponsors
Apply for patent	Sabbatical leave	Enter in Science Fair
Publish pre-prints	Summer school	Present paper at meeting
Press release	Inform colleagues	Commercialize process

Invention, technological design, new product idea

Do any of the above; make a model, apply for a patent, do market research, make an effort to gain acceptance, and sell or merchandise the product.

Decision, plan, dispute, social science problem, geography or history research, the arts.

Do any of the above. Implement a solution, if possible. Prevent problem in the future.

Recommendations—If submitted to authoritative body, wait for review. If modified, rejected, or partially accepted, you will have to coil back to one of the earlier ingredients and work ahead again.

New problems—Solving one problem often leads to new problems. Maybe you made some surprise discoveries or saw opportunities for research in new areas. Consider all consequences—make predictions. Offer clues and leads. Mention in your report.

Obstacles to acceptance—Many eventually highly successful hypotheses have had a very rough road to acceptance. Others have won immediate popularity. Thus, your action may have to include overcoming these obstacles that cause people to reject new things:

Jealousy	Resistance to change	Organized skepticism
Bias	Loss of prestige	Wrong assumptions
Financial loss	Not enough proof	Poor reasoning
No market	Authoritarianism	Won't admit wrong

Aids to acceptance—All through your problem solving you must think of ways to gain acceptance. Review these and investigate any other ideas. Now develop and apply them. Use your communication skills. From start to finish, we use curiosity. You must also evaluate your action—look back! Are results as expected? Must you modify anything? Use retrospect.

ALWAYS THE INQUIRING MIND

FAMOUS EXAMPLES OF:

MOTIVATION AND SENSITIVITY

Arjen Lenstra and Mark Manasse were faced with a factoring-of-numbers problem that could have taken many years to solve. Sensitive to the need for a timely solution, they enlisted the aid of over 1,000 scientists and mathematicians all over the world via fax and other electronic means. The problem was solved in less than a year.

Many children have been sensitive to needs, have solved problems, and invented very useful items. In 1873, young Chester Greenwood (age 15) invented earmuffs! Other examples: George Ferris, Jr., invented the ferris wheel; Levi Strauss, the Levi jeans. Join your school's "Invent America" club, International Science & Engineering Fair, or other helpful extra-curricular programs.

TO CHOOSE A CAREER:

MOTIVATION AND SENSITIVITY

Be sensitive to all input, especially your needs, interests, abilities, and ambition. You know yourself better than anyone else knows you. Do some serious self-analysis by taking a personal inventory—identify your values, interests, and talents. Ask yourself, "What do I want to do with my life? What motivates me?" Is it desire to help society? Money? Interest in the work? Job security? Job prestige? A desire for a fulfilling family life? In what subject area does your memory work best?

PART IV—Supporting Ingredients
In utilizing THE GENERAL PATTERN OF THE SCIENTIFIC METHOD, these very important ingredients will help and influence your actions.

(Ingredient #12) **(12)**

MOTIVATION AND SENSITIVITY

MOTIVATION

Our actions are influenced by motivation, which is stimulated by certain needs, instincts, desires, and emotions. Some of these are:

Love	Curiosity	Social status	Goal seeking
Fear	Food & water	Self-preservation	Achieve potential
Hate	Self-esteem	Financial gain	Recognition hunger
Joy	Physical needs	Usefulness	Sensory stimulation
Comfort	Happiness	Adversity	Anxiety and anger

There are times when we must solve problems of necessity, for school, to satisfy parents, and for other special reasons. *It can be fun and is a part of the essence of life!*

Some basic motivations for problem origination and solving are the joys of:

Financial gain	Discovery	Problem solving
Feeling important	Taking risks	Being successful
Competition	Teamwork	Self-improvement
Teaching	Helping others	Fame and prestige
Intellectual achievement	Work	Competence
Satisfying curiosity	Creation	Good school grades
Contributing to humanity	Learning	Being useful
Eliminate state of doubt		Need to know
Dedication to organization and family		Being an innovator

Sort out and utilize your emotions to help you with SM-14

SENSITIVITY

Sensitivity to people and to things is part of problem origination and solving.

People (awareness of)

Needs and desires	Dissatisfactions	Actions and reasoning
Emotions	Motivations	Self-image
Values and morals	Social relations	Ambitions and hopes

Things (increased awareness of)

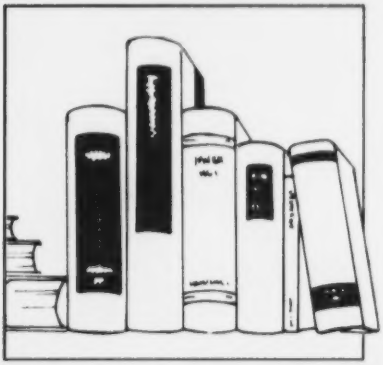
Need to learn	Environment	Purposes	Opportunities
Improvements	Creative endeavors	Patterns	Values/criteria
Communications	Conceptual blocks	Inquiries	Problem solving
Mental alertness	Organizational needs	Challenges	Differences
Innovations	False assumptions	Leads	Hidden points
Classifications	Community needs	Systems	New technologies

Struggle is the essence of life!

The essence of struggle is to become a good problem solver. SM-14 shows you the route to solving complex problems. Be confident—you can do it!

FAMOUS EXAMPLES OF:

PERSONAL ATTRIBUTES



This booklet is also dedicated to the past and present members of the intellectual community from whose books and publications I have compiled most of the information in this pamphlet. So many works have been reviewed, it is not possible to credit individuals. They used their many personal attributes productively. Thanks to them all!

Let us also remember the millions of other scientists, researchers, inventors, and problem solvers who have displayed curiosity, persistence, creativity, and honesty in their work. We need to thank them for their contributions to world knowledge and for trying to make this world a better place in which to live.

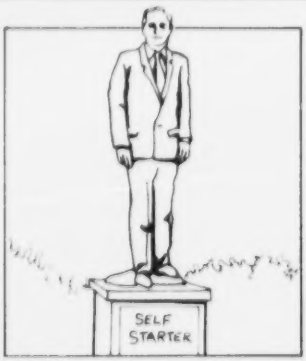
This pioneering booklet is making history! Because of the 40-year-old controversies over the existence of "The Scientific Method," nothing like it has ever been written. In the years that lie just ahead, this booklet will be constantly upgraded, expanded, improved, and computerized. Save this edition—it may be a collector's item one day!

TO CHOOSE A CAREER:

PERSONAL ATTRIBUTES

Smart career investigation and decisions require a variety of attributes. Some important and necessary personal attributes are:

- Patience—Finding answers takes time. Use initiative.
- Persistence—Don't give up.
- Courage—Face disappointment.
- Honesty—Be honest with yourself. Know your limits.
- Self-education—It's your personal problem. You must devote time and effort to improve your career knowledge.



(Ingredient #13)

PERSONAL ATTRIBUTES (13)

A definition of personal attributes also includes character traits, aptitudes, skills, values, attitudes, etc. We are concerned here with those needed to use **THE GENERAL PATTERN OF THE SCIENTIFIC METHOD**.
Some important ones are:

HONESTY	Integrity/ethical/unbiased/impartial
PROGRESSIVENESS	Initiate changes that improve
SELF-EDUCATION	Always trying to learn more
CURIOSITY	An inquiring mind
MOTIVATION AND SENSITIVITY	Alert & moved to solve problems
INITIATIVE	Self-starter—gets things done
CREATIVITY	Develop new ideas and solutions
INNOVATIVENESS	Apply and adapt anyone's ideas
SELF-CONFIDENCE	Good self-image/self-sufficient
COMMUNICATION SKILLS	Expressive—verbal and written
SELF-SACRIFICE	Delays gratification
SELF-CORRECTING	Admits own faults and mistakes
COURAGE	Risk taker and endures failure
FLEXIBILITY	Can adapt to change—ingenious
PRODUCTIVITY	Personally effective and efficient
EXPERIMENTAL INCLINATION	Tries new ways, tests
TOLERANCE	Of other views and races
RESPONSIBILITY	Can be depended UPon

ALERTNESS OF MIND—REFLECTIVE THINKING

Open-minded	Interpreting	Objective	Uses imagery
Relates ideas	Perceptive	Introspective	Decisive
Evaluating	Analyzes	Tactically alert	Competitive
Reasoning	Conjecturing	Forecasts	Healthy skepticism

AMBITIOUS—INDUSTRIOUS—ENERGETIC

Goal-oriented	Leader	Passion for subject	Accepts responsibility
Persistent	Aggressive	Task-oriented	Thinks ahead
Progressive	Dependable	Desirous to improve	Organized

SKILLFUL—QUALITY MINDED

Reading	Generalizing	Troubleshooter	Planning
Initiative	Writing	Typewriting	Computer friendly
Statistics	Mathematical	Communicating	Abstracting
Measuring	Accurate	Organized	Manual dexterity
Improvising	Visualizing	Meticulous	Technological

COOPERATIVE AND POSITIVE ATTITUDE—LOVE OF COUNTRY

Team worker	Tolerant	Respects teacher	Relates to others
Does homework	Respects school	Maintains discipline	Good self-image
Time-conscious	Admits ignorance	Accepts criticism	Doesn't discriminate
Sense of humor	Controls emotions	Seeks truth	Avoids misconceptions

Develop a good overall personality and the ability to get along with others. Great developments and improvements are usually a result of team effort.

John Dewey (1859-1952), America's greatest educator-philosopher, wrote many books. The most famous is How To Think. He was a great advocate of reflective thinking. He asserted that "the method of science-problem solving through reflective thinking should be both the method and valued outcome of science instruction in America's schools."

Thomas H. Huxley, a famous 19th-century English philosopher, claimed, "We are all scientists." He reasoned that "the method of scientific investigation is nothing but the necessary mode of working of the human mind." This is what makes SM-14 such a fundamental formula. This pamphlet just presents it in clearer terminology and manner.

ADDITIONAL HELPFUL INFORMATION ON CAREERS

Libraries—Check your school and other libraries for career books, etc.
SM-14—Will be a tremendous help if you ever decide to change careers.
Intuitive Base—The more career information you retain in memory, the more precise your career decisions will be.
Day on the Job—Arrange to spend a day "on the job" in types of careers in which you are interested. Participate in Career Day or Week activities.
Watch and Take Advantage of

- Career school counselors
- Career centers and exhibits
- Special newspaper career sections
- Career newspapers and magazines
- Interviews about careers
- Scholarships
- Summer or after-school jobs
- Professional career counselors
- Cassettes and software on careers
- T.V. career programs
- Teacher's personal career advice
- Apprenticeships and internships
- Career courses and seminars
- Career and skill clinics

Books On Careers—For a free catalog on career books, write The New Career Centers, Inc.; P.O. Box 339-CT; Boulder, CO 80306.

(Ingredient #14) **(14)**

THINKING SKILLS, METHODS, AND PROCESSES

SM-14 uses thinking skills, methods, and processes which are necessary to effectively utilize the ingredients in Parts I, II and III. They support your efforts to do an efficient job of using SM-14.

THINKING SKILLS

In this limited space, it is not possible to do much more than impress on you the need to develop your ability to use the thinking skills necessary to adjust to the many changes in our fast-developing world.

On this page we will consider the two primary thinking skills which are always used in problem origination, solving, and challenge of solution. They are basic ways of thinking and are termed *induction* and *deduction*.

INDUCTION

This is another controversial subject. Some philosophers and scientists have advanced theories that claim there is no such thing. For you and I, however, the standard textbook definition is understandable. Professor Huxley gave this example many years ago:

Suppose you bit these small, hard, green apples. Each one tasted very sour.

You then make a generalization that all small, hard, green apples are probably sour. This is inductive reasoning.

(i.e., FROM THE SPECIFIC OR PARTICULAR TO THE GENERAL)

DEDUCTION

Then you picked up this small, hard, green apple:

By deductive reasoning, you decide it must be sour, too.

INTERPLAY OF INDUCTION AND DEDUCTION

In the big picture, *induction* is used from Problem Origination to the Hypothesis (Ingredients 1-7) and *deduction* for the Challenge and Conclusion (Ingredients 8-9). On the other hand, you will also be using *induction* and *deduction* on little decisions and sub-problems. *This characterizes one of our basic ways of thinking.*

METHODS AND PROCESSES

These words are often used interchangeably. SM-14 by itself will solve no problems! Rather, it is the *methods* and *processes* of a creative, logical, and technical nature used under the ingredients that will do the job. The methods of statistical analysis, mathematics, and measuring are used so often that you will find books on them.

You may have to search for information on or invent others. Some methods can be useful for almost any problem, while you may have to devise your own for problems which require specialized ones. These methods and processes will soon be available in an easier-to-find-and-use form. Many textbooks now offer a better presentation.

THE BEST WAY TO IMPROVE YOUR INTELLIGENCE AND THINKING SKILLS IS TO LEARN HOW TO USE SM-14!

INGREDIENT #14—SUPPLEMENTARY PAGE

THINKING SKILLS MOVEMENT

Realization of the need to teach *thinking* has been revived in the educational field. This movement is gaining momentum each year. This is a very encouraging and progressive development.

Various Names for Thinking Skills

Higher-order thinking skills	Basic thinking skills
Higher-order intelligence skills	Directed thinking
Critical thinking	Intelligence applied
Core thinking skills	Street smarts
Practical intelligence	Many others

What you should do

If your school has a thinking skills course or is incorporating it into regular classes, take full advantage of the opportunity. If there is none, ask why; and encourage your parents to ask why. For self-help, read books on the subject, study this pamphlet, and do plenty of reflective thinking and problem solving.

Problem Origination and Solving are the basis for Thinking Skills

John Dewey (1859-1952), America's greatest educator-philosopher, stated that "origin of all thinking is some perplexity, confusion or doubts" . . . in other words—problem origination and solution. He advocated the use of "The Scientific Method." Thus, you would think that all of the thinking skills programs would include problem origination and solving.

However, I surveyed 33 thinking skills programs and only about 10% of them included a problem-solving formula. If you have a choice, pick one that includes creativity and problem solving.

In my Idea and Research Report, I stress the great need for a good standard program on thinking skills. It should be taught across the curricula, with SM-14 as the base.

THERE IS MORE TO INTELLIGENCE THAN JUST A HIGH IQ

A high IQ is not a complete indicator of intelligence; nor is it the only determining factor for success. Many people with an average academic IQ make a major contribution to progress.

Because of dissatisfaction with the usual multiple choice tests, research on required student portfolios, projects, and performance tasks is underway. This will call for problem origination and solving. **Be prepared—study SM-14.**

In the meantime, analyze yourself. In what area do your abilities seem strongest? Consider planning your career and self-development accordingly. Some intelligences, traits, and abilities mentioned in the literature are:

Academic	Innovation	Communicating	Bodily—kinesthetic
Artistic	Judgment	Inter-personal	Logical—mathematical
Creativity	Linguistic	Intra-personal	Mental—self-management
Dexterity	Mechanical	Musical	Real world abilities
Empathy	Motivation	Spatial	Street smarts

AIDS AND SUGGESTIONS FOR SEARCHING, EXPLORING, AND GATHERING EVIDENCE

1. "HOW TO DO IT" REFERENCE BOOK. Knowing Where To Look. (1988). Tells where to find information. Available from Writers Digest Books, 1507 Dana Avenue, Cincinnati, Ohio 46207, or bookstores.
2. PREPARE LIBRARY PROGRAM. Investigate local libraries and take any scheduled library tours. Take library science course at school. For books your library doesn't have, ask to borrow through inter-library loan from other libraries or branches.
3. PERIODICALS AT LIBRARY. Browse through a variety of magazines and newspapers, the greatest sources of information and *idea triggers*. Examine reference book section. Consult periodical indexes and "Books in Print" for help on your subject.
4. COMPUTER ACCESS TO LITERATURE. Availabilities are growing swiftly. Check library and other sources, such as *Database Searcher*.
5. HOLD BRAINSTORMING SESSIONS. Talk to yourself out loud . . . or use someone as a *sounding board*.
6. ORGANIZE YOUR DATA. Set up a good filing system. Inexpensive plastic crate files are available at office supply and discount stores. Also utilize computer, if available, both for searching and storing data. Avoid carelessness and sloppy paperwork.
7. CHECK TELEPHONE YELLOW PAGES for new and used bookstores. Call for categories available and price ranges. Visit used book stores.
8. ORGANIZATIONS, PROFESSIONAL SOCIETIES, GOVERNMENT AGENCIES. These can provide you with domain-specific data. Watch for scheduled exhibits. The library has directories for all of these.
9. USE POST-IT NOTES™ to mark pages you want to copy or review. Use yellow highlighter on your <u>own</u> material for emphasis.
10. KEEP TRACK OF NAMES of articles and books you may have to cite.
11. FREE HELP. Discuss your subject with anyone familiar with it . . . a relative, friend, teacher, business colleague, or professional person—draw them out. Pick their minds. Challenge them. Make notes for review.
12. STUDY GROUP. Form a group of others who have similar interests.
13. Analyze unexpected failures or events for clues for new direction to go.
14. "Facts" can frequently be wrong. Be skeptical! Use the word "data."
15. Be alert to surprise discoveries, which may cause you to go in a more important direction or investigate a completely different problem.

Learn To Abstract Concepts From Material You Read
College professors complain that many students who come to them do not know how to dig out and comprehend the basic principles and concepts in the material assigned. You must train yourself to do this. Reflect after reading—what is really important? What concepts and what basic principles are involved? List these for study and review.

INGREDIENT #5—SUPPLEMENTARY PAGE

Innovation and creativity are very important—study the next four pages carefully!

SOME WAYS TO BE INNOVATIVE AND CREATIVE

The Thinker
Just reflective thinking:
8 hours produces 2 good ideas

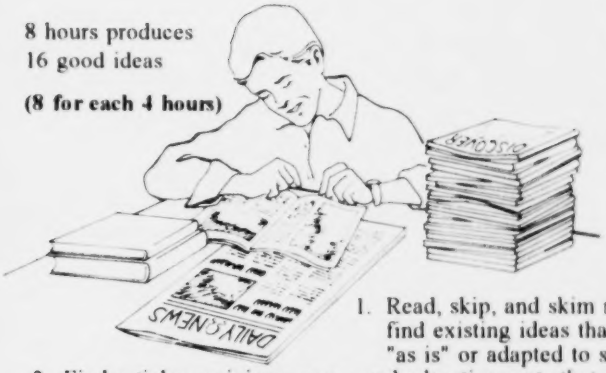
(1 for each 4 hours)

Group Brainstorming
In a 2-hour session with 4 people, 8 good ideas are produced

(4 for each 4 hours)

8 hours produces
16 good ideas

(8 for each 4 hours)



SEAGEE™
S earch
E xplore
A ltemative Ideas
G ather evidence
E valuate
E ducated guess

BE MORE PRODUCTIVE

1. Read, skip, and skim many publications; find existing ideas that can be used "as is" or adapted to suit your own needs.
2. Find articles, opinions, news, and advertisements that stimulate or trigger reflective thinking, imagination, illumination, gradual insight, or long-term memory as well as working memory. This produces new ideas, concepts, leads, or clues.
3. Use library, subject files, telephone, fax machine, computer, and discussions with others. Have a continuous learning program.

INGREDIENT #5—SUPPLEMENTARY PAGE

INNOVATION AND CREATIVITY PAVE THE ROAD TO SUCCESS

In researching for this booklet, I read a great deal about the large number of changes that are coming, what employers will be demanding, etc. Combining this information with my many years of experience as an employer, it can all be summarized in one statement.

In order to succeed—you must study, learn, and practice to be innovative and more creative!

In this golden age of knowledge, information will be increasingly easier to look up with the use of fast-developing technologies. Using innovation, you are going to need SM-14 as a guide to its application. Since situations vary greatly, some creativity will have to be used to adapt new knowledge to your particular problem. Study Pages 34-37 on Innovation and Creativity!

Naturally creative—Some people are blessed with this attribute.
Children are usually naturally creative—Many schools are now trying to develop this as the child progresses through all grades.
Innovation and creativity—They can be learned and developed, but this requires behavior changes and development. It is well worth the effort. You should motivate yourself to do it. Take any courses available. Read about it.

Becoming a Better Innovator is Much Easier than Becoming Very Creative
Innovator—Loves ideas, new things. An innovator does not necessarily create these ideas or new things but utilizes curious observation to seek out the ones suitable for his/her use and purpose. By using a little ingenuity, innovators adapt these ideas or new things to fit their personal or job-related needs.
Ideas Need Not Be New—There are many thousands of good ideas not being utilized. Seek them out! Look internationally as well as at home.
Risk Taker—An innovator must have the nerve to take risks and accept occasional failures. From these, he/she learns to be more successful.
Leadership Requires Innovation—A leader must have ideas and be able to introduce change and improvement. America needs more innovative leaders.

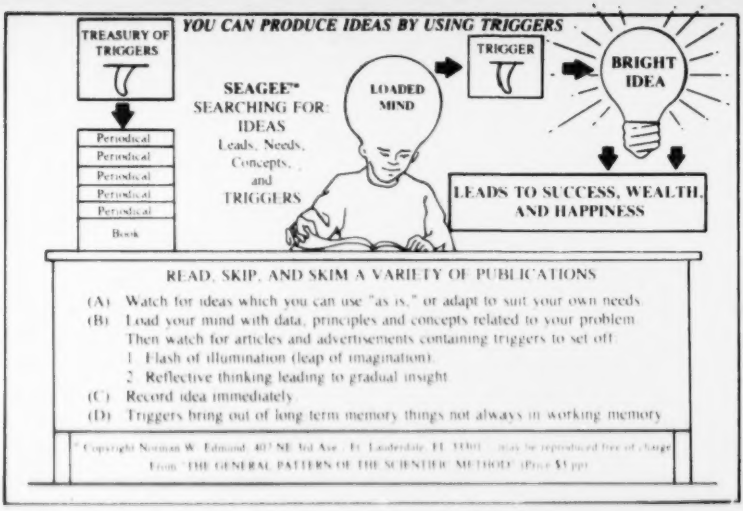
****

"It has often been said that the greatest
discovery in science was the discovery of
the scientific method of discovery," which is:
THE GENERAL PATTERN OF THE SCIENTIFIC METHOD

****

Do Your Homework . . . and More

The global competition mentioned on Page 38 and 44 means that our progressive educators will have no choice but to increase their emphasis on homework. *Realize the need and do your homework carefully and completely!* One or your greatest desires is to have a happy and fulfilling family life. Let this motivate you to prepare *now* for a secure future. Spend some spare time reading. When watching television, search for educational programs—you'll find many are very entertaining too!


YOU CAN PRODUCE IDEAS BY USING TRIGGERS
TREASURY OF TRIGGERS
Periodical
Periodical
Periodical
Periodical
Periodical
Book
SEAGEE™ SEARCHING FOR IDEAS
Leads, Needs, Concepts, and TRIGGERS
LOADED MIND
TRIGGER
BRIGHT IDEA
LEADS TO SUCCESS, WEALTH, AND HAPPINESS
READ, SKIP, AND SKIM A VARIETY OF PUBLICATIONS
(A) Watch for ideas which you can use "as is," or adapt to suit your own needs.
(B) Load your mind with data, principles and concepts related to your problem. Then watch for articles and advertisements containing triggers to set off:
1. Flash of illumination (leap of imagination).
2. Reflective thinking leading to gradual insight.
(C) Record idea immediately.
(D) Triggers bring out of long term memory things not always in working memory.
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From "THE GENERAL PATTERN OF THE SCIENTIFIC METHOD" (Price $3ppd)

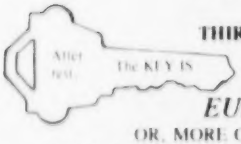
TRY IT . . . IT WORKS!

YOU CAN PRODUCE IDEAS AND SOLUTIONS WITH REST-ILLUMINATION OR REST-REFLECTIVE GRADUAL INSIGHT

FIRST—Load your mind with (in relation to your problem):
INFORMATION THEORIES DATA
CONCEPTS BASIC PRINCIPLES

SECOND—Rest your mind by:

Sleep or preparation for sleep | Vacation Travel Hobby | Exercise Shower Grooming | Work on a different project



THIRD—Don't just wait. You must start to think reflectively about your problem again.

EUREKA! A FLASH OF ILLUMINATION . . .
OR, MORE OFTEN, A GRADUAL INSIGHT TO AN
IDEA—SOLUTION—DECISION—LEAD—CLUE—THEORY—CONCEPT
Write it down immediately!

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BEST COPY AVAILABLE

INGREDIENT #5—SUPPLEMENTARY PAGE

(MAKE COPIES FOR YOUR NOTEBOOK, POSTING, OR GIVING TO FRIENDS)

NORM EDMUND'S ADVICE ON HOW TO BE MORE INNOVATIVE AND CREATIVE

1. *Learn to be a perpetual innovator*—someone who seeks out, adapts, and implements ideas—new or old. Actively look for ideas by reading, skipping, and skimming through many periodicals, books, reports, catalogs, etc. Also:

Experiment	Brainstorm	Attend conferences and exhibits
Search files	Have discussions	Use computer idea programs
Travel	Sense felt needs	Browse through stores, etc.

2. *Change your behavior and self-image.* Be progressive, develop necessary attributes and motivation. Develop a love for new ideas, new things, new ways, new technologies, new systems. Put your ideas in writing.

3. *Take action!* Have the courage and self-confidence to be an innovator. Dare to be different! Failure will occur—but we learn from our mistakes. Emotions can aid creativity—control stress. Be persistent.

4. *Welcome change & challenge of problems*—be open-minded, flexible.

5. *Apply ideas* to every facet of your life—in your personal affairs, career, school, business—everywhere. Always ask: In what alternative and better ways can it be done? Generate innovative and creative solutions, ideas, concepts, and theories. Develop a sense of humor. Be sensitive to opportunities. Use checklists.

6. *Study innovation, change and creativity* as well as how to win idea acceptance. Educate yourself. Take any courses available. Develop a passion for your problem. Learn to be a good team member, leader, and perpetual innovator.

7. *Be curious and observant.* Develop a spirit of inquiry. This is the way to originate problems. Practice using The Golden Formula, which is "THE GENERAL PATTERN OF THE SCIENTIFIC METHOD." Avoid constraints on your thinking. Spot key factors.

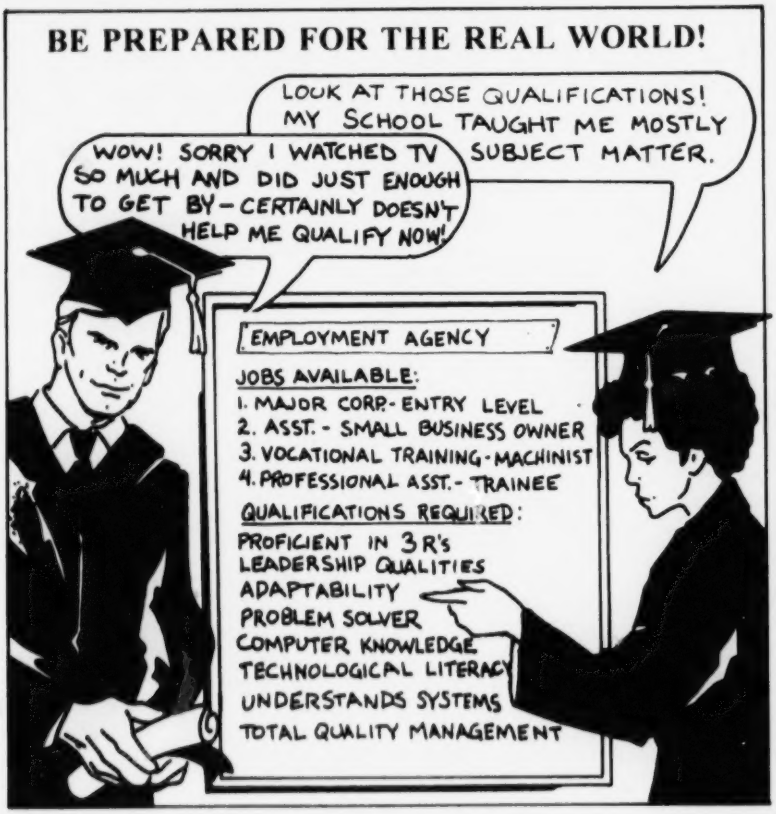
8. *Ask What, Why, Which, Where, When, Who, How, If.* Constantly reflect on all aspects of your problems. Don't pre-judge ideas too soon. Don't let your ego stop you from saying, "I goofed!"

9. *Develop your reflective thinking ability and thinking skills.* Daydream about your problem. Jump back and forth among logical, critical, judicial, imaginative, and wild thinking. Improve your thinking skills through study and practice.

10. *Build your knowledge and intuition base* through reading and other activities. Keep neat files. Learn how to research, to visualize.

11. *With a loaded mind, use triggers* to stimulate ideas, insight, and illumination. Utilize activities listed in #1 above to trigger your storehouse of memories and connect with what you read, hear, see, or think, thereby producing ideas by gradual insight or illumination. Be sensitive to opportunities.

12. *Load your mind* with data, basic principles, theories, and concepts about your problem—REST—then be sure to start thinking of your problem again. Gradual insight or a leap of the imagination may occur.


BE PREPARED FOR THE REAL WORLD!
LOOK AT THOSE QUALIFICATIONS! MY SCHOOL TAUGHT ME MOSTLY SUBJECT MATTER.
WOW! SORRY I WATCHED TV SO MUCH AND DID JUST ENOUGH TO GET BY - CERTAINLY DOESN'T HELP ME QUALIFY NOW!
EMPLOYMENT AGENCY
JOBS AVAILABLE:
1. MAJOR CORP. - ENTRY LEVEL
2. ASST. - SMALL BUSINESS OWNER
3. VOCATIONAL TRAINING - MACHINIST
4. PROFESSIONAL ASST. - TRAINEE
QUALIFICATIONS REQUIRED:
PROFICIENT IN 3 R's
LEADERSHIP QUALITIES
ADAPTABILITY
PROBLEM SOLVER
COMPUTER KNOWLEDGE
TECHNOLOGICAL LITERACY
UNDERSTANDS SYSTEMS
TOTAL QUALITY MANAGEMENT

The U.S. Department of Labor's SCANS

(Secretary's Commission on Achieving Necessary Skills)

SCANS found that over one half of our students are not qualified for the real world. Here are a few abbreviated quotations from their report:

For most of this century, as this nation took its goods and know-how to the world, America did not have to worry about competition from abroad. Today, the demands on business and workers are different. Firms must meet world class standards and so must workers. Employers seek adaptability and the ability to learn and work in teams. . . . good jobs depend on people who can put knowledge to work. Most workers must be creative and responsible problem solvers and have the skills and attitudes on which employers can build. Traditional jobs are changing and new jobs are created everyday. High paying but unskilled jobs are disappearing. Employers and employees share the belief that all workplaces must "work smarter."

USE OF SM-14 PREPARES YOU FOR THE REAL WORLD

Reproduced below is a chart from the SCANS report (mentioned on the previous page). Please note:

If you study and practice the use of SM-14 and follow the advice in this booklet, you will acquire most of the know-how that is specified. You will become an even better problem originator and solver, as SCANS calls for problem solving but offers no formula like SM-14.

WORKPLACE KNOW-HOW

The know-how identified by SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. These include:

COMPETENCIES—effective workers can productively use:

- **Resources**—allocating time, money, materials, space, and staff.
- **Interpersonal Skills**—working with teams, teaching others, serving customers, leading, negotiating, and working well with people from culturally diverse backgrounds.
- **Information**—acquiring and evaluating data, organizing and maintaining files, interpreting and communicating, and using computers to process information.
- **Systems**—understanding social, organizational, and technological systems, monitoring and correcting performance, and designing or improving systems.
- **Technology**—selecting equipment and tools, applying technology to specific tasks, and maintaining & troubleshooting technologies.

THE FOUNDATION—competence requires:

- **Basic Skills**—reading, writing, arithmetic and mathematics, speaking and listening.
- **Thinking Skills**—thinking creatively, making decisions, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning.
- **Personal Qualities**—individual responsibility, self-esteem, sociability, self-management, and integrity.

—FOR INFORMATION ON SCANS, CALL (800)788-SKILL—

Exercise Problems—Textbook Problems—Puzzle Problems

These are used extensively in your school work and tests. While usually referred to as "problems," they really should be called what they are—one of the above names. Schools are teaching the methods, techniques, formulas, strategies, and domain-specific information needed to solve them. Unfortunately, this does not give you the complete real world training that you get from SM-14.

WILL YOU BE TAUGHT PROBLEM SOLVING IN SCHOOL?

Students Want It

Many studies have shown that students are bored with the usual subject-oriented curricula. They welcome a curricula where inquiry, discovery, methods, and real (not just textbook/puzzle type) problem solving are taught—realizing that this will prepare them for everyday life. Here is why you may have to study SM-14 and problem solving on your own.

Curricula Concentrated on Teaching Subject Matter

Otto Hollaway, in *Problem Solving: Toward A More Humanizing Curriculum* (1975), states what happened to our education system:

> Many leading educators endeavored to launch reforms after World War II aimed at making education more responsive to the needs of students and a democratic society. A large number of outstanding experimental programs were moving effectively forward but were challenged by critics of life-centered, problem-centered education like Bestor, Conant, Hutchins and Rickover. These critics and many others became more vocal following the launching of Sputnik in 1957. Such events created doubt in the minds of many Americans concerning the quality of American education and its leadership. Pressures demanded a return to the uniform college preparatory, subject-centered curriculum.

We have many curricula reform programs today, but most do not include real problem solving, "The Scientific Method," or SM-14.

Erroneous and Unfruitful Concept that "The Scientific Method" Does Not Exist

Dr. Conant (1893-1978), in the 1947-1961 period, wrote several books expressing his opinion that "The Scientific Method" did not exist. Because of his great prestige as President of Harvard University and his reputation as "one of the great teachers and scientists of our age," his followers have injected this erroneous and unfruitful concept into all past and current national school reform efforts.

Also, only about 10% of our thinking skills programs include problem solving (see page 32).

Most Reform Reports Call for Teaching Creativity and Problem Solving

If these reports are followed by officials and school leaders, changes may be on the way. So far, however, the changes have been few.

What You Should Do!

As a student, you should request local, regional, and national officials to initiate programs for teaching SM-14 across the curricula.

Your science teacher may already be teaching a little of "The Scientific Method" (although this is threatened by the Science Standardization Movement). Ask for more detailed teaching about it.

Study this booklet on your own, as well as with your parent and/or teacher's help.

PRACTICAL HELP WITH EVERYDAY PROBLEMS & DECISIONS

The full SM-14 formula is usually for complex, ill-structured problems that require research and study. However, problems come in a variety of complexities. Here is a shortened formula:

SM-7 FOR INTERMEDIATE-TYPE PROBLEMS AND DECISIONS

(Can also be used as a preliminary or introduction to teaching the full SM-14 formula)

Ingr. No.	SM-14 No.	Short Name — SM-7 Short Scientific Method—7 Ingredients, Labeled A to G
A	1	***Curious Observation.*** Find a problem.
B	2	***Is There A Problem?*** Consider purpose, define problem, and estimate requirements to solve problem, all in relation to the time available.
C	4	***Search—Explore.*** Review and reflect mentally for solutions. If important enough and time is available, gather evidence as described on Pages 11 & 33. Your *intuitive base* may supply you with answers.
D	5	***Alternative Solutions.*** Be sure to devote enough time to generating logical or creative alternative solutions. See Pages 13, 34-37.
E	6	***Evaluate.*** If it is an important problem or decision, you must evaluate, rate, and challenge all possible solutions. Again, memories of past experiences in your intuitive base may be of help.
F	7	***Guess—Hypothesis.*** Time may force you to settle for "good enough."
G	11	***Take Action!***

INSTANTANEOUS DECISIONS AND PROBLEM SOLUTIONS

In the course of a day you make hundreds of simple decisions and problem solutions, usually based on your intuition. They are called by such names as:

Snap judgment	Quick guess	Habit decision
Intuitive decision	Trial and error solution	Instantaneous decision
Leap of understanding	Good enough	Shoot from the hip
Emotional decision	Off the top of your head	Arbitrary guess
Immediate apprehension	Jumping to a conclusion	Hasty decision

A visualized solution—instantly picturing a solution in your mind

Many of these solutions and decisions are really simple, unimportant, and in the habit-type class. Others are of varied importance that you make instantly because of time frames, a good-enough answer will suffice, or you have self-confidence in your intuition. Since some may be important, too many errors can hurt your success, relationships, or reputation. Therefore, it is important to develop your intuition.

FOR REAL LIFE SUCCESS, BUILD A VARIED INTUITIVE BASE

Your intuitive decisions and problem solutions are based on your body of subject knowledge, experiences, ideas, methods, formulas, basic principles, concepts, patterns, relationships, etc. that you retain in your working and long-term memory.

Build a good self-development program to develop your base ***(SEE PAGE 45).***

ADVICE TO THOSE NOT GOING ON TO COLLEGE

Make sure that you realize that we are in an age of many changes and increased competitiveness. Read Pages 38, 39, and 44.

Do these things while you are still in high school:

1. Discuss your intentions with your school counselor or look for an advisor.
2. Read the career pages of this booklet carefully and develop a career plan.
3. Remember that there are many abilities besides academic ones. Read Page 32. Study your aptitudes.
4. You must have a good base of reading, writing, speech, and as much math as you can master. If weak in any one, take remedial courses. You will discover the importance of this in your job interviews. Take action now!
5. Start a self-development plan. See Page 45.

After graduation . . .

You may be at a disadvantage compared to people with higher education, but you can offset this by taking corrective action. Millions have done so, and you can, too—but you must motivate yourself. Conventional ways to offset the lack of higher education:

- Evening classes
- Specialized day courses
- Apprenticeship
- Vocational school
- Self-education plan
- Mail-order or home computer courses
- On-the-job training
- Start your own business

Weaknesses—If you have any weakness in reading, writing, mathematics, speech, or other important subjects, you should take courses to correct them.
Poverty, Illness, Job Loss—These have forced many a great person into a job not of their first choice. By a self-improvement program, personal sacrifice, night school, determination, creativity, and innovation, people have succeeded in changing their lives for the better.
Real World Smarts—By getting actual experience in the job, you have the opportunity to get a real world education that someone in school will not get for years. Make the most of it! Read your daily newspaper! Develop and follow a continuous learning schedule.
Self-Development Program—Read Page 45. Review it again and again. *Start a real continuing* self-development program. Improve and develop desirable attributes (see page 29).

What It Takes To Get A Job

Richard Bolles, in his best-seller, What Color Is Your Parachute?, lists the crucial things necessary for getting a job:
Experience—Credentials—Problem Solving—with the key being **Problem Solving.** Wow! Thus, you should practice SM-14 *(The Golden Formula).*

Buy or Beg a Computer for Home Use

Do not underestimate the importance of having access to a computer—become proficient in using it! Be willing to sacrifice in order to obtain one. If you can't afford a new one, ask someone (family, friend, corporation) to donate one being replaced. Learn the basics, including typing.

GET BETTER GRADES—LEARN HOW TO LEARN

Learning how to learn is an important skill to acquire. Throughout your life you will be told to learn this—learn that—study this—remember that. You must learn the little skills, methods, processes, and strategies of how to learn. You must assume the responsibility for your own learning. Do you do best auditorily, visually, or hands-on? A combination? Special time of day? In groups, in classes? Other ways? We have stages of mental development. There are slow and fast learners. Each of us is somewhat different, so you must determine your learning style and improve it.

Master the art of *learning how to learn* and you will:

- spare yourself countless hours of ineffective study;
- raise your school and employment application test grades;
- improve your self-educational ability; learn how to improve attributes;
- be rewarded with a much more successful life.

Learn how to study. Set priorities to allow sufficient study time. Motivate yourself with a positive attitude and control stress and self-doubt. Start a study group—it is often effective. Take care of your health. Find a quiet place to study, free of distractions. Use a marking pen and Post-it™ notes. Make neat notes, including flash cards, that are easy to review.

Learning aids—use them to help you learn. Learning can be facilitated by curiosity, experimentation, discussion, interviews, and everyday experiences. Also, learn by using computers, instruments, books, periodicals, TV, radio, imagery, symbols, idea trees, analogies, pictures, graphs, sketches, concept maps, checklists, teaching aids, and flow charts.

All of these learning aids are employed in problem solving, so use SM-14!

Build your basic knowledge and intuitive base. It will be more difficult to learn how to learn if you don't have a solid base of reading, writing, vocabulary, mathematics, listening, speaking, and measuring skills (and experiences). *Learn thinking skills* and practice them.

Learn to abstract concepts, basic principles, or basic data. You will be asked to read books and chapters that are filled with more information than you can possibly remember. Read; analyze; evaluate; pick out just the theories, basic principles, or important data. List, review, and commit to working memory for easy retrieval. Learn how to take tests.

Learn to transfer knowledge. If you solve a problem, be alert to recognize how you can apply the same methods in another area. Learning structure, concepts, and basic principles makes the transfer of knowledge easier.

Other strategies or suggestions. Use methods rather than haphazard procedures. Be self-confident. Learn to use your imagination! Get proper nutrition and rest. Pay close attention when teachers explain how to learn.

ARE YOU TRAINABLE? PREPARE YOURSELF!

Employers need people who are trainable. You must develop the essential personal attributes and basic skills of reading, writing, and arithmetic.

Right attitude	Solid basic education	Ethical work habits
Ability to adapt	Flexibility for change	Good problem solving
Good teamwork	Proficient work skills	Productivity awareness

CHANGES . . . AND HOW THEY AFFECT YOU

An ever-increasing number of changes are going to affect your life. Below are just a few of the trends with which you should familiarize yourself.

THIS IS AN AGE OF GLOBAL COMPETITION AND A WORLD POPULATION EXPLOSION

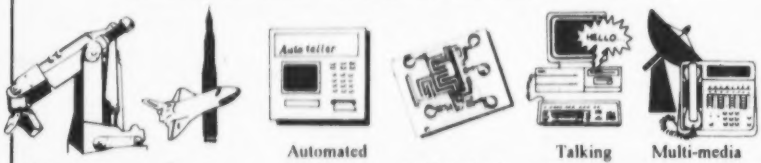
Billions of people throughout the world are willing to work for 10¢-20¢-$1.00/hour

THIS IS THE GOLDEN AGE OF KNOWLEDGE!

Estimated years it took for knowledge to double
1750-1900: 150 yrs 1900-1950: 50 yrs
1950-1960: 10 yrs Since 1960: Every 5 yrs

Projection! By the Year 2020, knowledge will double every 73 days!
We need to study and standardize on the basic method by which we refine, extend, and apply knowledge . . . which is, SM-14 (*The Golden Formula*).

THIS IS AN AGE OF TECHNOLOGICAL GROWTH!



Robots | Space | Automated Tellers | Miniaturization | Talking Computers | Multi-media Communications

High-paying unskilled jobs are disappearing—skilled, innovative, creative, problem-solving, adaptable workers are needed!

THIS IS AN AGE TO IGNORE HARMFUL PEER PRESSURE AGAINST STRIVING TO ACHIEVE IN SCHOOL!

It is the future minimum wage earners, the unemployables, the misguided, who will give you this advice.
DON'T BE ONE OF THEM—DON'T LISTEN TO THEM!

PREPARE! DEVELOP A SELF-DEVELOPMENT PLAN.

PREPARE A SELF-DEVELOPMENT PROGRAM

1. You must motivate yourself to improve and develop—student or adult.
It is a frightening (but challenging) economic forecast! Because of world competition, you will have to work smarter and become more innovative and creative than your parents were in order to be equal to or to exceed their economic status. Allocate your time wisely. Lead a balanced life using all resources. Don't devote ***excessive*** time to:
TV watching *Idle music listening* *Competitive sports activities*
"Hanging out" *Spectator sports* *Sleeping*
Respect your parents and teachers. Maintain good communication with them. Look to your parents for religious guidance. Utilize your school counselor. *Remember, self-improvement is **your** responsibility.*

2. Have an educational and personal learning program.
Be sure that you have a good base of reading, writing, speech, and math.

3. Build your intuitive base (page 41) & learn how to learn (page 43).
These are essential in this age of fast changes and knowledge explosion.

4. Develop your thinking skills and other intelligences (page 32).
Learn methods and processes. Study and practice SM-14. Join others in problem projects.

5. Learn to be a better innovator and to become more creative.
Reread Pages 13 and 34-37. Innovation & creativity can pay off!
Take courses *Practice curious observation* *Be a SEAGEE™*
Keep idea book *Apply ideas at home* *Develop courage*

6. Keep up with how to retrieve information—learn systems and technologies.
Knowledge sources and the technology of retrieving information are developing faster, less expensive, more prolific, and universally available.
Become computer-friendly at school, home, etc.—expand your computer knowledge. In schools, offices, retail stores, warehouses, factories, farms, and restaurants—in fact, practically everywhere, you will be exposed to the use of a computer and new systems. Learn how to type!

7. Improve and develop desirable attributes.
Develop your overall personality. Reread Page 29. Think about these attributes often. Do things that will help you.
Join an organization (e.g., Scouts) *Get part-time jobs for experience*
Read self-improvement books *Read, skip, and skim periodicals*
Learn to be a good team member *Engage in helpful hobbies*
Practice tolerance of others *Enter science & engineering fairs*
Take part in school, company, religious, and civic activities
Learn to work quickly and effectively—improve your personal efficiency!

8. Career. Prepare a career plan or a career investigation plan.

9. Personal health program.
Say NO to drugs *Develop proper eating and exercise habits*
Maintain emotional stability *Have regular physical exams*
Don't abuse your body or take unnecessary risks

10. Set goals and keep updating your self-development program.

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LIBERAL FREE USAGE OF COPYRIGHT

I undertook this project mainly as a public service. My basic objective is to get widespread usage of the booklet. For details on free use of material, write to me.

I am delighted to announce an endorsement of SM-14!

Dr. W.I.B. Beveridge is the author of the famous and often-cited books, *The Art of Scientific Investigation* (1957) and *Seeds of Discovery* (1980). He was one of the first to challenge Sir Karl Popper's concept that there was no logic to context of discovery. After reading my booklets, he writes, "Your proposal to teach SM-14 not only to young scientists but also as part of general education is excellent, and I wish you success."

Your Help is Needed!

Because of the 40 years of a prevailing, erroneous, and unfruitful concept that "The Scientific Method" was only an alleged method, few people are very familiar with it. I urge my readers to correct this progress-impeding situation! Please help spread the word about the value of SM-14 by:

Tell friends about it	Discuss it at professional meetings
Write articles concerning it	Encourage media to publicize it
Use in your organization	Acquaint educational leaders
Teach students	Acquaint political leaders

A MESSAGE ON HOW I CAME TO WRITE THIS BOOKLET

In 1942, after a long illness, I started a little business selling chipped-edge lenses by mail in New Jersey. My office was a card table in a small bedroom in my parents' apartment.

By 1961, Edmund Scientific Company had a 24,000-square-foot plant in Barrington, New Jersey, where we sold a large variety of optical and scientific items.

It was my habit to read, skip, and skim through about 200 magazines a month, looking for new products, progressive developments, and ideas. I ran across Dr. Crooks' article on "Suggestions for Teaching the Scientific Method" in the March 1961 issue of American Biology Teacher. A flash of inspiration told me that I should write an easy-to-read, illustrated booklet based on his article. I made a file and started an idea notebook. But I goofed! I didn't fully realize the urgent need for this particular booklet.

By 1975, the Edmund Scientific plant had grown to a 68,000-square-foot building. I retired to Florida after turning the business over to my son to expand. I had good intentions of working on this booklet and other projects, but my passion for fishing and boating distracted me.

In May of 1989, at age 73, I decided to work on "The Scientific Method" booklet in order to have it ready for Edmund Scientific's 50th Anniversary in 1992. I quickly discovered it to be a far more important, complex, and controversial subject than I had ever envisioned; and I adopted it as a personal retirement project. Our Fort Lauderdale home dining room table and garage were soon overflowing with books, so my wife and I purchased a small office. I gave up boating and fishing and devoted my full attention to the project. My library grew from a few books to over 1,000. I completed the booklet in April 1992 and the second edition in October 1993.

I sincerely urge you to read, reread, and apply the information in this booklet. It was the self-development plan I started when I was fifteen years old that really helped me to succeed. Be sure to read Page 45 and start yours today! It can greatly improve your life. Remember—read, reread, and reread this booklet for continuous reinforcement. Apply SM-14 to originating and solving problems and get plenty of practice. Start at once!

Yours for greater success through self-development,

Norm Edmund

Norman W. Edmund

Acknowledgments—See also Page 28

My thanks to my former Secretary-Assistant, Risa Reynolds; to Gail Schuster, my present Secretary-Assistant; to my granddaughters—Rachel Husted for her help during the summers of 1989-90-91 and Nicole Sloan for graphic design; to Ken Crooks, Jr., his mother, and other family members; to Ignacio and Janis Garcia for graphic design and editorial review; to Deby Stewart for help with our computer; to the Broward County Library System (especially those who handle inter-library loans); and last, but really foremost, my wife and family for their support, encouragement, and help.

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will produce unlimited
• CHANGES • CHALLENGES • OPPORTUNITIES
in all fields

• Knowledge will be our biggest industry and job producer.
• Be prepared for these changes, challenges and opportunities.
• **Improve your intelligence and thinking skills.**
Learn to use SM-14.

We make hundreds of decisions and solve many problems every day. These range from quick snap decisions to more complex and ill-structured problems that require time and reflective thinking.

The key to originating and solving problems and also to making decisions is The General Pattern of the Scientific Method (SM-14).

Don't be haphazard about your happiness, success, and preparation for a good and fulfilling family life. Prepare a self-development program. Page 45 of this booklet will help you.

Learn and Practice The Golden Formula for this Golden Age of Knowledge

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD

SM-14